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List of physical constants

The constants listed here are known values of physical constants expressed in SI units; that is, physical quantities that are generally believed to be universal in nature and thus are independent of the unit system in which they are measured. Many of these are redundant, in the sense that they obey a known relationship with other physical constants and can be determined from them.

Table of physical constants

Symbol	**Quantity**	**Value**[a][b]	**Relative standard uncertainty**	**Ref**
c	speed of light in vacuum	299 792 458 m⋅s^{-1}	0	[1]
h	Planck constant	6.626 070 15 × 10^{-34} J⋅Hz^{-1}	0	[2]
$\hbar = h/2\pi$	reduced Planck constant	1.054 571 817... × 10^{-34} J⋅s	0	[3]
μ_0	vacuum magnetic permeability	1.256 637 062 12(19) × 10^{-6} N⋅A^{-2}	1.5 × 10^{-10}	[4]
$Z_0 = \mu_0 c$	characteristic impedance of vacuum	376.730 313 668(57) Ω	1.5 × 10^{-10}	[5]
$\varepsilon_0 = 1/\mu_0 c^2$	vacuum electric permittivity	8.854 187 8128(13) × 10^{-12} F⋅m^{-1}	1.5 × 10^{-10}	[6]
k, k_B	Boltzmann constant	1.380 649 × 10^{-23} J⋅K^{-1}	0	[7]
G	Newtonian constant of gravitation	6.674 30(15) × 10^{-11} m^{3}⋅kg^{-1}⋅s^{-2}	2.2 × 10^{-5}	[8]
$k_\mathrm{e} = 1/4\pi\varepsilon_0$	Coulomb constant	8.987 551 7923(14) × 10^{9} N⋅m^{2}⋅C^{-2}	1.5 × 10^{-10}	[9]
Λ	cosmological constant	1.089(29) × 10^{-52} m^{-2}	0.027	[10]
$\sigma = \pi^2 k_\mathrm{B}^4 / 60\hbar^3 c^2$	Stefan–Boltzmann constant	5.670 374 419... × 10^{-8} W⋅m^{-2}⋅K^{-4}	0	[11]
$c_1 = 2\pi h c^2$	first radiation constant	3.741 771 852... × 10^{-16} W⋅m^{2}	0	[12]
$c_{1\mathrm{L}} = 2hc^2/\mathrm{sr}$	first radiation constant for spectral radiance	1.191 042 972... × 10^{-16} W⋅m^{2}⋅sr^{-1}	0	[13]
$c_2 = hc/k_\mathrm{B}$	second radiation constant	1.438 776 877... × 10^{-2} m⋅K	0	[14]
b [c]	Wien wavelength displacement law constant	2.897 771 955... × 10^{-3} m⋅K	0	[15]
b' [d]	Wien frequency displacement law constant	5.878 925 757... × 10^{10} Hz⋅K^{-1}	0	[16]
b_entropy	Wien entropy displacement law constant	3.002 916 077... × 10^{-3} m⋅K	0	[17]

e	elementary charge	1.602 176 634 × 10^{-19} C	0	[18]
$G_0 = 2e^2/h$	conductance quantum	7.748 091 729... × 10^{-5} S	0	[19]
$G_0^{-1} = h/2e^2$	inverse conductance quantum	12 906.403 72... Ω	0	[20]
$R_\mathrm{K} = h/e^2$	von Klitzing constant	25 812.807 45... Ω	0	[21]
$K_\mathrm{J} = 2e/h$	Josephson constant	483 597.8484... × 10^{9} Hz·V^{-1}	0	[22]
$\Phi_0 = h/2e$	magnetic flux quantum	2.067 833 848... × 10^{-15} Wb	0	[23]
$\alpha = e^2/4\pi\varepsilon_0\hbar c$	fine-structure constant	7.297 352 5693(11) × 10^{-3}	1.5 × 10^{-10}	[24]
α^{-1}	inverse fine-structure constant	137.035 999 084(21)	1.5 × 10^{-10}	[25]
m_e	electron mass	9.109 383 7015(28) × 10^{-31} kg	3.0 × 10^{-10}	[26]
m_p	proton mass	1.672 621 923 69(51) × 10^{-27} kg	3.1 × 10^{-10}	[27]
m_n	neutron mass	1.674 927 498 04(95) × 10^{-27} kg	5.7 × 10^{-10}	[28]
m_μ	muon mass	1.883 531 627(42) × 10^{-28} kg	2.2 × 10^{-8}	[29]
m_τ	tau mass	3.167 54(21) × 10^{-27} kg	6.8 × 10^{-5}	[30]
m_t	top quark mass	3.0784(53) × 10^{-25} kg	1.7 × 10^{-3}	[31]
$m_\mathrm{p}/m_\mathrm{e}$	proton-to-electron mass ratio	1 836.152 673 43(11)	6.0 × 10^{-11}	[32]
$m_\mathrm{W}/m_\mathrm{Z}$	W-to-Z mass ratio	0.881 53(17)	1.9 × 10^{-4}	[33]
$\sin^2\theta_\mathrm{W} = 1 - (m_\mathrm{W}/m_\mathrm{Z})^2$	weak mixing angle	0.222 90(30)	1.3 × 10^{-3}	[34]
g_e	electron *g*-factor	−2.002 319 304 362 56(35)	1.7 × 10^{-13}	[35]
g_μ	muon *g*-factor	−2.002 331 8418(13)	6.3 × 10^{-10}	[36]
g_p	proton *g*-factor	5.585 694 6893(16)	2.9 × 10^{-10}	[37]
$h/2m_\mathrm{e}$	quantum of circulation	3.636 947 5516(11) × 10^{-4} $\mathrm{m}^2\cdot\mathrm{s}^{-1}$	3.0 × 10^{-10}	[38]
$\mu_\mathrm{B} = e\hbar/2m_\mathrm{e}$	Bohr magneton	9.274 010 0783(28) × 10^{-24} J·T^{-1}	3.0 × 10^{-10}	[39]
$\mu_\mathrm{N} = e\hbar/2m_\mathrm{p}$	nuclear magneton	5.050 783 7461(15) × 10^{-27} J·T^{-1}	3.1 × 10^{-10}	[40]
$r_\mathrm{e} = e^2k_\mathrm{e}/m_\mathrm{e}c^2$	classical electron radius	2.817 940 3262(13) × 10^{-15} m	4.5 × 10^{-10}	[41]
$\sigma_\mathrm{e} = (8\pi/3)r_\mathrm{e}^2$	Thomson cross section	6.652 458 7321(60) × 10^{-29} m^2	9.1 × 10^{-10}	[42]
$a_0 = \hbar^2/k_\mathrm{e}m_\mathrm{e}e^2 = r_\mathrm{e}/\alpha^2$	Bohr radius	5.291 772 109 03(80) × 10^{-11} m	1.5 × 10^{-10}	[43]
$E_\mathrm{h} = \alpha^2c^2m_\mathrm{e}$	Hartree energy	4.359 744 722 2071(85) × 10^{-18} J	1.9 × 10^{-12}	[44]
$\mathrm{Ry} = hcR_\infty = E_\mathrm{h}/2$	Rydberg unit of energy	2.179 872 361 1035(42) × 10^{-18} J	1.9 × 10^{-12}	[45]

$R_\infty = \alpha^2 m_\mathrm{e} c / 2h$	Rydberg constant	10 973 731.568 160(21) m^{-1}	1.9×10^{-12}	[46]
$G_\mathrm{F} / (\hbar c)^3$	Fermi coupling constant	$1.166\,3787(6) \times 10^{-5}$ GeV^{-2}	5.1×10^{-7}	[47]
N_A, L	Avogadro constant	$6.022\,140\,76 \times 10^{23}$ mol^{-1}	0	[48]
$R = N_\mathrm{A} k_\mathrm{B}$	molar gas constant	8.314 462 618 153 24 $\mathrm{J{\cdot}mol^{-1}{\cdot}K^{-1}}$	0	[49]
$F = N_\mathrm{A} e$	Faraday constant	96 485.332 123 310 0184 $\mathrm{C{\cdot}mol^{-1}}$	0	[50]
$N_\mathrm{A} h$	molar Planck constant	$3.990\,312\,712\,893\,4314 \times 10^{-10}$ $\mathrm{J{\cdot}s{\cdot}mol^{-1}}$	0	[51]
$m(^{12}\mathrm{C})$	atomic mass of carbon-12	$1.992\,646\,879\,92(60) \times 10^{-26}$ kg	3.0×10^{-10}	[52]
$M(^{12}\mathrm{C}) = N_\mathrm{A} m(^{12}\mathrm{C})$	molar mass of carbon-12	$11.999\,999\,9958(36) \times 10^{-3}$ $\mathrm{kg{\cdot}mol^{-1}}$	3.0×10^{-10}	[53]
$m_\mathrm{u} = m(^{12}\mathrm{C})/12$	atomic mass constant	$1.660\,539\,066\,60(50) \times 10^{-27}$ kg	3.0×10^{-10}	[52]
$M_\mathrm{u} = M(^{12}\mathrm{C})/12$	molar mass constant	$0.999\,999\,999\,65(30) \times 10^{-3}$ $\mathrm{kg{\cdot}mol^{-1}}$	3.0×10^{-10}	[54]
$V_\mathrm{m}(\mathrm{Si})$	molar volume of silicon	$1.205\,883\,199(60) \times 10^{-5}$ $\mathrm{m^3{\cdot}mol^{-1}}$	4.9×10^{-8}	[55]
$\Delta\nu_\mathrm{Cs}$	hyperfine transition frequency of $^{133}\mathrm{Cs}$	9 192 631 770 Hz	0	[56]

Uncertainties

While the values of the physical constants are independent of the system of units in use, each uncertainty as stated reflects our lack of knowledge of the corresponding value as expressed in SI units, and is strongly dependent on how those units are defined. For example, the atomic mass constant m_u is exactly known when expressed using the dalton (its value is exactly 1 Da), but the kilogram is not exactly known when using these units, the opposite of when expressing the same quantities using the kilogram.

Technical constants

Some of these constants are of a technical nature and do not give any true physical property, but they are included for convenience. Such a constant gives the correspondence ratio of a technical dimension with its corresponding underlying physical dimension. These include the Boltzmann constant k_B, which gives the correspondence of the dimension temperature to the dimension of energy per degree of freedom, and the Avogadro constant N_A, which gives the correspondence of the dimension of amount of substance with the dimension of count of entities (the latter formally regarded in the SI as being dimensionless). By implication, any product of powers of such constants is also such a constant, such as the molar gas constant R.

See also

- List of mathematical constants
- Physical constant

- List of particles

Notes

a. The values are given in the so-called *concise form*; the number in parentheses is the *standard uncertainty* and indicates the amount by which the least significant digits of the value are uncertain.

b. In some instances an exact value has been displayed, calculated from the defining expression, rather than the incomplete decimal expansion as given by the source.

c. $b = \frac{hc}{k\left(5 + W_0\left(-5e^{-5}\right)\right)}$, where W_0 is the principal branch of the Lambert *W* function.

d. $b' = \left(3 + W_0\left(-3e^{-3}\right)\right)\frac{k}{h}$, where W_0 is the principal branch of the Lambert *W* function.

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